

## **Appendix 1: Features of the HFOV devices**

A high frequency oscillator generates a biphasic waveform with both positive and negative pressure deflections around a defined mean airway pressure (MAP). The MAP is built up with variable or fixed bias flows, and various types of semi occlusive valves in the expiratory limb. To be a true oscillator, the magnitude of the negative pressure wave deflection should be roughly equal to that of the positive pressure deflection when operating with equal inspiratory and expiratory cycle durations. This biphasic pressure waveform is generated either by a piston moving back and forth (piston HFO ventilators), or by a variety of venturi and jet injector configurations (non-piston HFO ventilators).

Piston devices work either by an electromagnetically driven vibrating diaphragm (Sensormedics® 3100A, Sensormedics, CareFusion, San Diego and Fabian-HFO® with a neonatal and pediatric mode, Acutronic Medical Systems AG, Hirzel, Switzerland), a linear motor piston pump device (Humming X®, Metran, Japan) or a “two-valve oscillation pressure generation” device (Stephanie®, Stefan, Gackebach, Germany). See below some illustrations of the principle of functioning of some devices:

- Sensormedics®: This electromagnetic flow generator produces oscillations with a large loudspeaker membrane, and is suitable for use beyond the neonatal period. It produces an active exhalation, which is essential at high-frequency respiratory rates to prevent air trapping that may occur with passive exhalation. As with piston oscillators, a bias flow system supplies fresh gas. However, this device cannot be used for combined conventional ventilation and HFOV.

D. Jamal et al. / *Réanimation* 13 (2004) 54–61

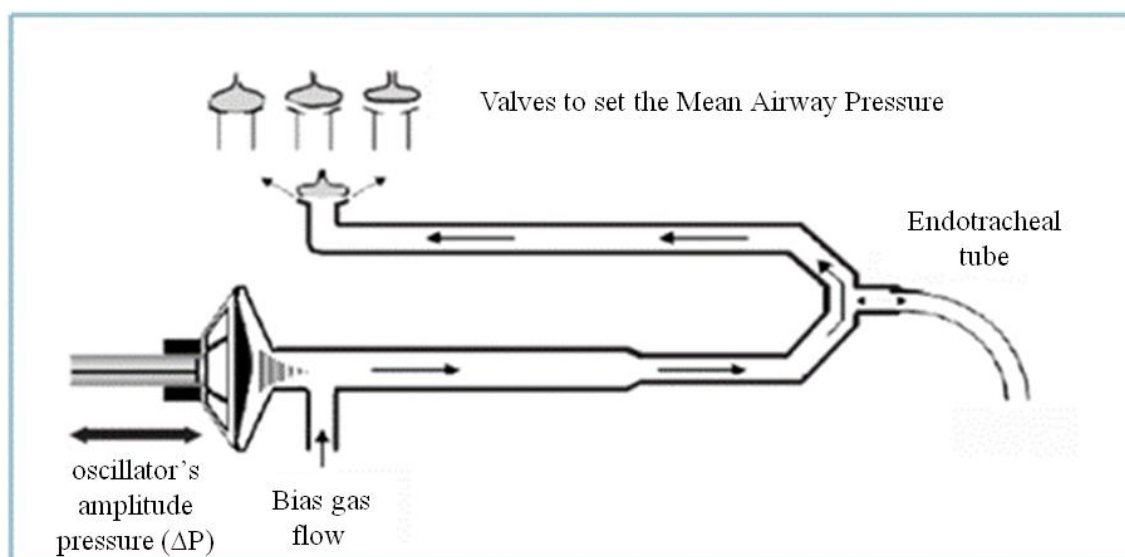


Figure 1: Illustration of the principle of functioning of the SensorMedics®. This electromagnetic flow generator produces oscillations with a large loudspeaker membrane.

- Stephanie® (Stefan GmbH, Gackenbach, Germany). This valve oscillator with active expiration employs a piston pump to move a column of gas rapidly back and forth in the breathing circuit. It determines the stroke volume, which is therefore fairly constant. A bias flow system supplies fresh gas.

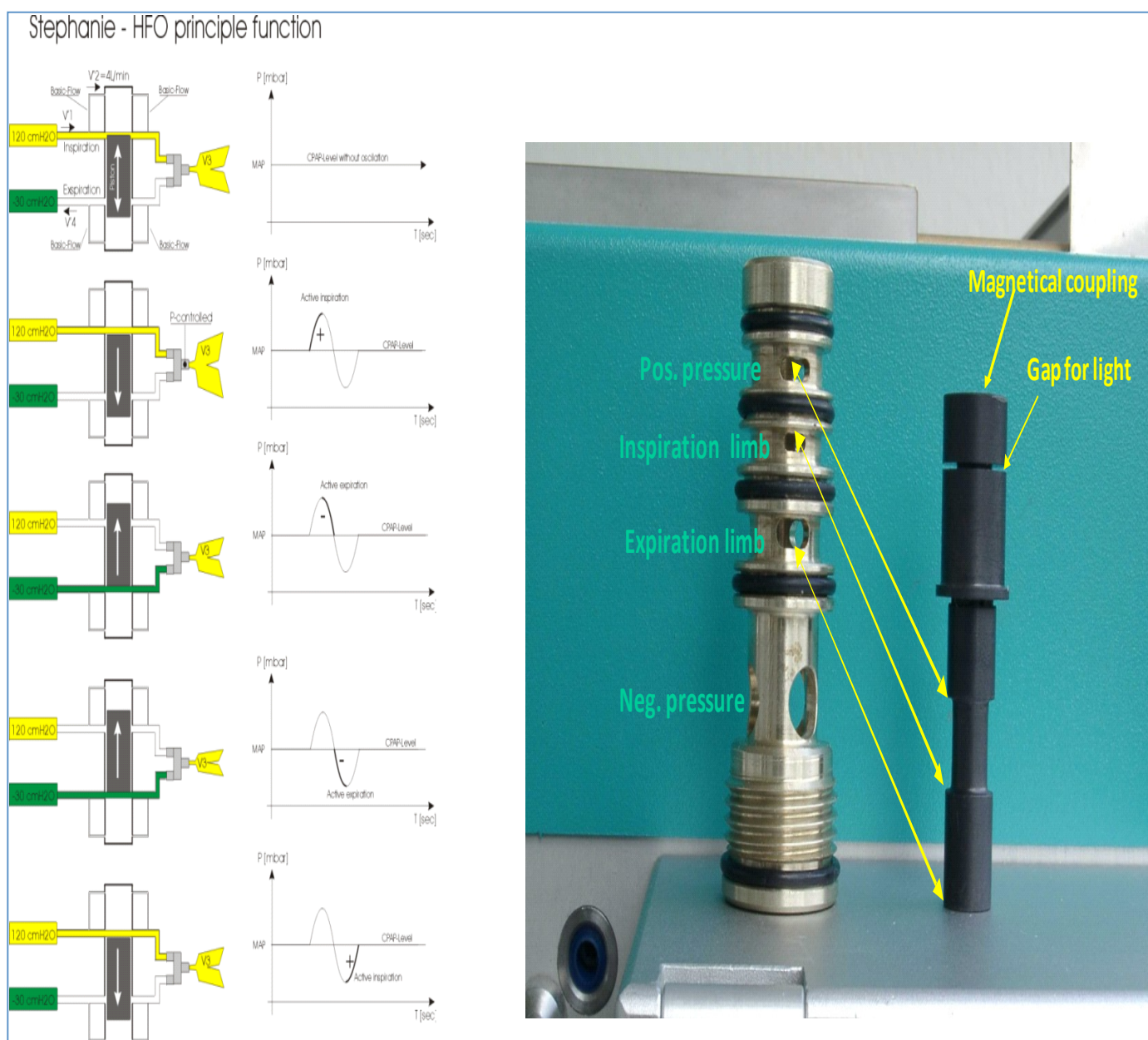


Figure 2: Illustration of the principle of functioning of the Stephanie®: The valve oscillator with active expiration employs a piston pump to move a column of gas rapidly back and forth in the breathing circuit.

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Contemporary non-piston devices include concepts like “flow modulated sine wave” generation (Babylog® VN500 Dräger Inc., Lübeck, Germany). This device features an expiratory valve with Venturi-assisted expiration: the “flow interrupters” section the gas flow in the patient circuit at a high rate, thereby causing pressure oscillations. Their power, however, depends on the respiratory mechanics of the patient. Another non piston device is a

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valveless system (SLE® 6000, SLE Ltd, South Croydon, UK). This valveless system with bidirectional jets provides sinusoidal ventilation with active expiration. A constant flow of fresh gas is supplied to the patient circuit at a rate of 8 L/min. The expiratory manifold has three jets. The front jet is used to generate an opposing flow to the fresh gas in the exhalation manifold, thereby creating a Positive End Expiratory Pressure. The rear jet is used to generate the peak inspiratory pressure in the same way. A third (reverse) jet is used during high-frequency oscillation to produce active negative pressure and to help eliminate excess circuit pressure. Software controls the rate and duration of the flow of gas being driven into the exhalation manifold in opposition to the fresh gas flow.

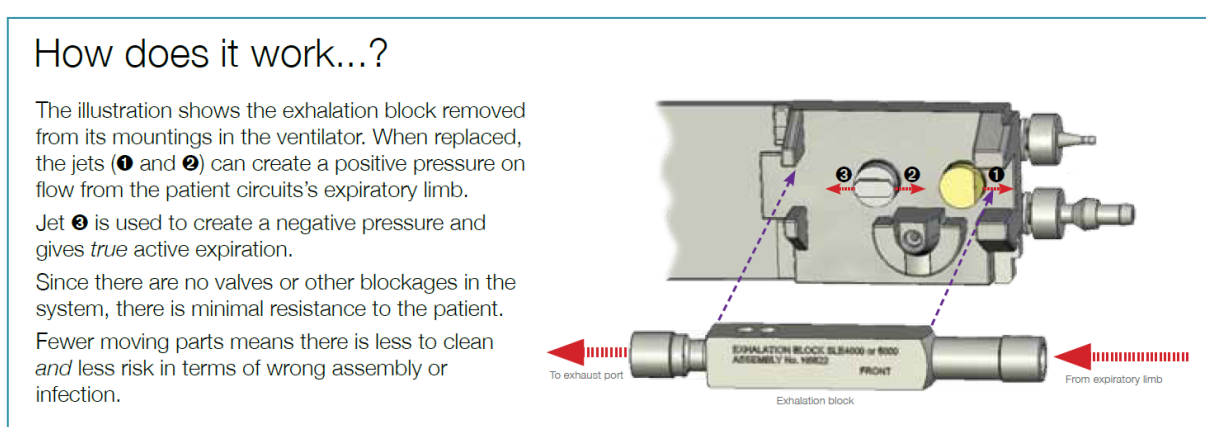


Figure 2: Illustration of the principle of functioning of the SLE®. This valveless system with bidirectional jets provides sinusoidal ventilation with active expiration.

Another non piston is the SERVO-n® HFOV prototype, Maquet, Solna, Sweden. It's a newer concept that relies on the inertia of the air in the patient circuit when the pressure at airway opening is rapidly modified combined with very fast responding inspiratory valves and high flow capability.